Research on the Cultivation of "Computational Thinking" Ability in the Course of "University Computer Foundation"

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Abstract. In view of the existing computer course teaching model of the old problem, this paper uses the North American advanced BOPPPS teaching model, to cultivate students' computational thinking ability as the guidance, in the "University computer Foundation" course will be "computational thinking". The course is classified according to chapter contents, and computational thinking reflected in different teaching contents is explored. BOPPPS teaching design is carried out for the cultivation and training of computational thinking, so that knowledge is expanded with the explanation of thinking, thinking is formed with the penetration of knowledge, and ability is improved with the understanding and training of thinking, and finally the purpose of effective teaching is achieved.

Keywords: BOPPPS model · Computational thinking · Computer foundation · Effective teaching

1 Introduction

Computational thinking is the necessary thinking ability for people to successfully integrate into the society. The effective use of computer analysis and problem solving is the basic skill juxtaposed with reading, writing and arithmetic.

"College Computer Foundation" is the first computer course for college students after entering the university. It is a common basic course in all colleges and universities at present. This course requires students to have basic computer knowledge and use computers to solve practical problems in work and life, so as to lay a solid foundation for the future study of specialized courses.

Since 2008, the general education of the computing science, with the cultivation of the "the computational thinking", has become the mainstream of the basic computer education. In 2012, the Department of Higher Education of the Ministry of Education issued the Notice on announcing the List of University Computer Curriculum Reform Projects, which identified 22 topics, which marked that the course of "University Computer Foundation" had entered the curriculum reform stage with computer thinking training as the entry point.

"University Computer Foundation" is a basic course with the cultivation of computing thinking ability as the core. Through learning, college students' thinking and cognitive realm can be further improved, but also can broaden their understanding of scientific and technological knowledge. Combining the ideas of computer with other disciplines is an important link to cultivating innovative thinking, so that students can adapt to the changing information age with the fastest speed and the fastest way. For example, "programs" help build a thinking model to study automatic problem solving; "algorithms" help to help people think about ways. The course of "University Computer Foundation" is designed to explore this kind of thinking, expand this kind of thinking, train this kind of thinking, and let the computing thinking ability accompany the learning process. Liu Tianhua and Liu Yuyang proposed the basic ideas and specific methods of the reform of the integrated computing thinking, aiming to integrate the idea of computing thinking into the basic computer knowledge [1]; Mou Qin explored the teaching and learning mode of the course of Computer Foundation based on computing thinking [2]. These explorations are mainly carried out in the theoretical part, without precise computing thinking mining for the s.

2   Advantages of Using BOPPPS Model to "LAND" Computational Thinking

BOPPPS model is a model that can achieve effective teaching. Effectiveness here refers to effect, efficiency and benefit [3]. If the teaching effect is consistent with the expected learning purpose, it is effective; if the resources obtained by students are in direct proportion to the educational resources provided by teachers, it is efficient; if the educational expectations of a specific society or individual are consistent with the teaching objectives, it is effective.

BOPPPS mode puts forward a closed-loop process of "teaching purpose", "teaching behavior", "learning activity" and "teaching evaluation" in the organization and implementation of teaching [4]. In addition, while cultivating students' computer thinking ability, it can also help them solve the problems in the learning process, such as how to analyze problems, how to find the key and difficult points in learning, and how to reflect on the "dead ends" in learning. It requires students to carry out all-round participatory learning, think in participation and learn in participation. It is a very good tool for cultivating computational thinking [5]. Through classroom practice, it is proved that BOPPPS model can well carry the idea of computational thinking, and can realize the effective classroom teaching oriented by the cultivation of computational thinking ability.

3   The "LANDing" of Computational Thinking in the Course of College Computer Foundation

3.1   Classification of the Course Content of College Computer Foundation

The basic contents of College Computer Foundation include computing and society, introduction to Python, computational thinking, information coding and data representation, computer system, computer network and application, application basis of database

technology, scientific computing, and new technology of computer development, covering the knowledge of many courses of computer specialty. "Information Representation and Information Processing" and "Computational Thinking and Computer Problem Solving" are the two main clues to understand the content of the chapter[6]. Combing the whole course, according to the different training of students' computational thinking ability in different chapters, the course content is divided into three categories: basic theory type, thinking training type and application practice type, and different computational thinking training methods are adopted for different types of course content.

1) Basic Theory Type
The basic theory type is mainly based on the understanding and memory of knowledge. It contains basic concepts and scientific calculations, which are boring and belong to the memory level. Basic theories include computing and society, information, coding and data representation, computer systems, scientific computing, and new technologies for computer development.

2) Thinking Training Type
Thinking training is mainly to consciously train students' computational thinking ability, including algorithm learning, data structure learning, program structure learning, etc. It mainly focuses on programming exercises and belongs to the level of understanding and application. The thinking training type includes Python introduction and algorithm.

3) Application and Practice Type
Practical application is to enhance students' ability to apply knowledge and apply computational thinking methods, and the content can be implemented on the computer, which is closely related to social needs. Including computer network and application and database technology application basis.

3.2   Requirements for the Cultivation of Computational Thinking Ability in Three Content Types

The basic knowledge of computer is the basic condition for generating computational thinking, but it is difficult for students to grasp the core when facing complex knowledge. Therefore, the content of each chapter in the basic computer course should take the cultivation of computational thinking ability as the core, and should combine the three dimensions of "knowledge", "skill" and "thinking" to cultivate students' computational thinking ability.

1. Basic Theoretical Content
Through subtle guidance, the main points of knowledge can be connected in series. In the process of teaching, we should try our best to avoid paying too much attention to the main points of knowledge in traditional teaching, and fully explore the bright spots of computational thinking contained in the teaching process. For example, use

mathematical modeling to let students feel "abstract thinking"; explain the principle of Turing machine, let students understand "automation thinking".

2. Thinking Training Content

Specific learning of some algorithms in computational thinking, such as computational thinking and computer problem solving, systematic learning of knapsack thinking, recursive thinking, divide-and-conquer thinking, binary search thinking, etc., through the study of specific methods, the common ways of thinking in real learning life are systematically summarized and classified, so as to better use them in life and other professional learning in the future.

3. Application of Practical Content

In this kind of teaching content, we should train students' ability to use computers to solve problems, that is, the application of computational thinking ability.

3.3 Classroom BOPPPS Design Examples of College Computer Foundation with Different Contents

1) Basic theoretical design Example- "Von Neumann Architecture"

Table 1. "Von Neumann Architecture" BOPPPS Design Table.

Course title:	Von Neumann architecture
Bridge-in:	Watch the military exercise video and ask the teacher: What are the similarities and differences between shipboard computers and personal computers?
Objective:	Students can describe the five components of von Neumann architecture, draw the working principle diagram of automatic control thought of stored program, and explain the reason why computers adopt binary system.
Pre-assessment:	Inspection of previous task assignment: What are the components of a personal computer, an iPad, and a smartphone

Participatory learning:

Time	Ways of participation	Problem solved
5 minutes	Report	Computer hardware composition
10 minutes	Group cooperation Discussion	Working principle of shipboard computer
10 minutes	Group mutual evaluation	Main idea of von Neumann system

Post-assessment:	Ask questions and report in groups
Summary:	Composition of computer hardware system Von Neumann's core idea
Evaluation:	The abstract theoretical knowledge will be explained vividly, and the students will participate in the classroom to a high degree, so as to achieve the established knowledge, ability and emotional goals.

Table 2. "Control Structures in Python" BOPPPS Design Table.

Course title:	Control structures in Python
Bridge-in:	Play a game-guess the number
Objective:	Ability to write basic forms of select and loop statements; ability to orchestrate program statements in algorithmic logic using Python control structures
Pre-assessment:	Check the previously assigned tasks. Enter an integer and print its value. Complete the pretest on the basic data types and order structures from the previous lesson.

Participatory learning:

Time	Ways of participation	Problem solved
5 minutes	Report	Mastery of sequential structure
5 minutes	Game	Select the structure to introduce
10 minutes	Group cooperation	Write a game of guessing numbers

Post-assessment:	Question and group discussion
Summary:	Summarize the common errors in computer programming
Evaluation:	To achieve the established teaching objectives, students have mastered the ideas of stratification and division, and improved their computational thinking ability.

"Von Neumann Architecture" is a very important knowledge point in the university computer foundation course. When students learn this knowledge point, they feel that the theory is boring and the thought is abstract, which is not easy to understand and remember [7]. How to let students understand von Neumann architecture more intuitively and vividly? How to let students understand von Neumann architecture more intuitively and vividly? BOPPPS model can be used to design.The specific BOPPPS design is as Table 1.

2) Content design of thinking training Example- "Control Structures in Python"

"Control Structures in Python" is the second lesson in Chapter 2, Introduction to Python, which focuses on the three major structures in Python programming. The essence of computational thinking is abstraction and automation, that is to say, first abstract certain data structures and algorithms from the problems to be solved, and then write programs to be executed by computers [8]. This is consistent with the methods and steps of programming, so we can combine the theory of programming with the principle of computational thinking according to the characteristics of programming course, and effectively apply various functions of computational thinking to all aspects of classroom teaching to design BOPPPS model. The specific BOPPPS design is as Table 2.

3) Practical Content Design Example- "Database Fundamentals"

"Database Foundation" is the content of the first lesson of Chapter 8 Database Technology and Application, which involves the concept, development history and basic datamodel of database. The knowledge points are monotonous, scattered and abstract. In class, it is easy to become a situation of "cramming" for teachers and "cramming" for students. BOPPPS can be used for classroom design to improve, so that students can participate in teaching activities as much as possible, so that knowledge can be developed in the explanation of thinking, thinking can be formed in the penetration of knowledge, and in the process of continuous thinking, ability can also be improved. The specific BOPPPS design is as Table 3.

Table 3. "Database Fundamentals" BOPPPS Design Table.

Course title:	Database Foundation
Bridge-in:	Teachers ask what databases have been used in our daily study, work and life? Students discuss
Objective:	Students can tell the role and basic form of the data model; can model the data for simple problems and draw the E-R diagram
Pre-assessment:	Questionnaire Question 1. How do you keep a record of your exam results for each course in college? Question 2. Hypothetical demand upgrade: It is required to record all the course selection information of all the students in the class during the university period.

Participatory learning:

Time	Ways of participation	Problem solved
5 minutes	Discussion	Introduction of the database
10 minutes	Brainstorm	The function of the database
10 minutes	Jigsaw puzzle	Entity Relationship Diagram

Post-assessment:	Solve tasks and report
Summary:	Draw a mind map to build connections between knowledge
Evaluation:	To achieve the established teaching objectives and computational thinking training objectives.

4   Summary

The BOPPPS classroom content design of College Computer Foundation, which is oriented by the cultivation of computational thinking, can indeed cultivate students' computational thinking ability and achieve effective teaching, but the following aspects should also be paid attention to in the design process.

(1) Target first, and the other five links revolve around the target. A good classroom design should first determine a measurable learning goal from the perspective of students, and then guide the design of the other five links.
(2) Teachers should carefully design the process of participatory learning, including predicting students' behavior, setting time flexibly, guiding students to discuss and communicate, mobilizing students' enthusiasm to participate as much as possible, and collecting students' feedback regularly.
(3) Strengthen students' summary and precipitation process. Some students are immersed in divergent discussions and exchanges, which will inevitably deviate from the course objectives. The final summary is crucial to help students grasp the soul of the whole class.
(4) There is a teaching method, but there is no fixed method. When using BOPPPS model for teaching design, teachers should not rigidly adhere to the structure and order of the six modules of BOPPPS. Teachers should naturally integrate BOPPPS model into teaching design according to the teaching content and the corresponding computational thinking method.

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